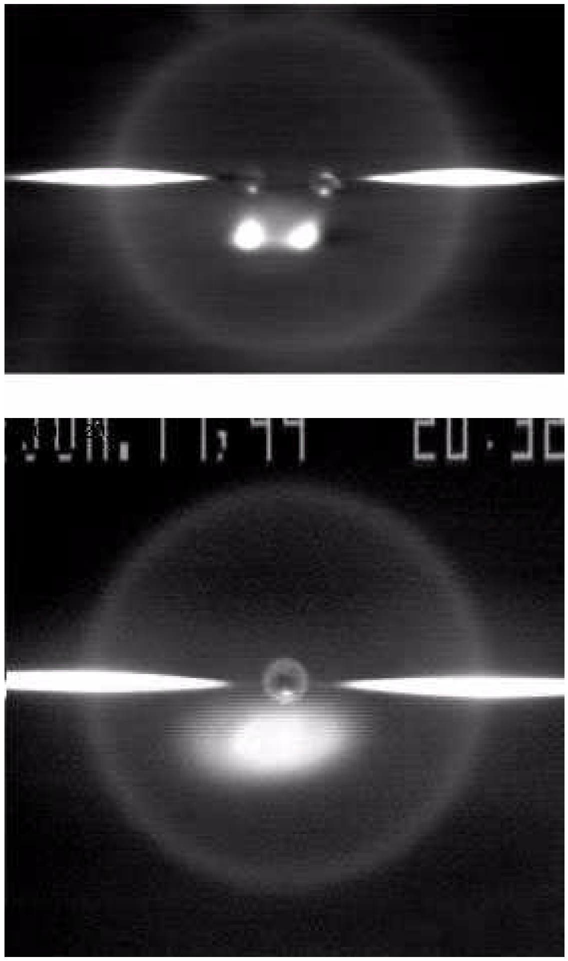
# Combustion of Interacting Droplet Arrays Being Studied

The combustion of liquid fuels is a major source of energy in the world today, and the majority of these fuels are burned in the form of a spray. This droplet combustion project at the NASA Glenn Research Center has the overall goal of providing a better understanding of spray combustion by extending existing studies of single droplets to a regime where droplet interactions are important (as occurs in a practical spray). The Combustion of Interacting Droplet Arrays is a collaborative effort between Glenn and the National Center for Microgravity Research. The group at Glenn also collaborates with scientists at the National Institute of Advanced Industrial Science and Technology in Hokkaido, Japan.

The project is studying the combustion of a small number of droplets suspended on small quartz fibers in a 0.1-atm combustion chamber. Data consist primarily of video images of the flames and droplets. The tests are being conducted in Glenn's reduced-gravity facilities (2.2-sec and 5.2-sec drop towers) and in the Japan Microgravity Center's 10-sec drop tower (JAMIC).

These two pictures show flame images from a single droplet (top) and a binary droplet array (bottom). The droplet size is the same in both pictures (the two droplets in the binary array are also equal in size). These images clearly show that the flame surrounding the droplet array is larger, as expected, and much dimmer. The dimness of the flame surrounding the droplet array implies that the flame is much weaker. Analysis of the droplet size data shows that the burning rate of the fuel droplets in the binary array is slower than that of the single droplet, again implying a weaker flame.



*Top: Single droplet. Bottom: Binary array.*

Recent work on this project has focused on comparing the extinction limits of binary arrays with those of single droplets. The results show that under certain ambient conditions (ambient pressure, ambient oxygen mole fraction, and diluent gas) droplet-droplet interactions can promote or enhance flame stability and that under other ambient conditions the opposite occurs (a single droplet has a more stable flame). The difference is related to the importance of radiative loss from the flame zone. For conditions where radiative loss from the flame zone is not important, interactions promote flame stability. If radiative loss is important, a single droplet will have a more stable flame. The latter condition applies to the images shown here (the single droplet has the more stable flame). The results from this work will be applied to droplet and spray combustion models to improve our ability to design spray combustors.

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